TECHNOLOGY LEADS NEW INDUSTRIAL REVOLUTION

The world is witnessing a third industrial revolution – the result of new technologies and novel materials that provide superior quality, reduce the cost of production and allow greater customization.

It comes almost a century after the second revolution when Henry Ford developed the moving assembly line and ushered in the age of mass production. He was a century after the first in the late 18th century with the mechanization of the British textile industry.

Digital Technology

The dramatic increase in computing power and capabilities has made digital technology ubiquitous in manufacturing. Advanced computing technologies for modeling and simulation now are used for design, engineering and testing.

Computer-aided design, engineering and manufacturing – known as CAD, CAE and CAM – allow suppliers to collaborate in the design, engineering and manufacturing processes. The surge in digital infrastructure expands opportunities by reducing barriers to new entrants and new competition. The exponentially advancing price and performance capability of computing, storage and bandwidth is contributing to an adoption rate for the digital infrastructure that is two to five times faster than previous infrastructures such as electricity and telephone networks. The cost of 1 million transistors has steadily dropped from over $222 in 1992 to 13 cents in 2010. That reduces the importance of scale, which increases opportunities for innovation.

Digital fabrication tools make it much easier to swap in new features, change a production line or restart production of old products if demand resurfaces. This helps manufacturers become more responsive to smaller groups of customers and allows greater customization.

New Materials

Manufacturing increasingly is using new materials that are stronger, lighter and more durable than traditional ones. Carbon fiber is replacing steel and aluminum in products ranging from bicycles to airplanes. It is flexible as a raw material, but when a carbon-fiber cloth is saturated with epoxy resin, shaped and cured, it can be as strong as steel at only half the weight. Another advantage is that single large pieces can be made rather than having smaller pieces riveted together to create a component.

Nanotechnology

Nanotechnology works at a miniscule level. A nanometer is a billionth of a meter. There are 25.4 million nanometers in an inch. A single-walled carbon nanotube could be scarcely a nanometer wide. About 100,000 nanotubes lined up side by side would equal the diameter of a single strand of hair.

By directing matter at the nanoscale, scientists achieve greater control over a material's properties, ranging from its strength and melting point to its fluorescence and electrical conductivity. Nanotechnology can give products enhanced features, creating bandages that help heal cuts, engines that run more efficiently, eyeglasses that don’t scratch and crockery that cleans more easily. Nanostructured catalysts make chemical manufacturing more efficient by saving energy and reducing waste. They also build new transistor structures and interconnect for the fastest, most advanced computing chips. Currently, more than 800 commercial products rely on nanomaterials, according to the U.S. National Nanotechnology Initiative. Manufacturing will increasingly take advantage of nanotechnology to create products with more strength, lighter weight, increased control of light spectrum or greater chemical reactivity than their larger-scale counterparts.

Idaho companies working with nanotechology include Applied Minerals in Osburn, GoNano Technologies in Moscow, Hewlett-Packard Co. and Micron Technology in Boise, Nano Steel in Idaho Falls and Positron Systems in Pocatello and Boise. The Idaho National Laboratory and the three state universities are conducting nanotechnology research.

Big Data

Advances in data acquisition and storage mean that immense amounts of data can now be continuously gathered and combined with other datasets. “Big data” involves analyzing that data to improve decision-making. It is the technique used by businesses to manage extremely large and complex sets of information and turn them into usable and actionable business intelligence. Information sets may include production machine data, sensor readouts, financial transactions, logistics statistics, customer interactions, bar-code data and Web analytics.

Big data can reduce production costs. Analysis of data from sensors and telematics can prevent breakdown of equipment and improve manufacturing output.

Companies are using big data to better understand consumers and to deliver better customer service. It allows narrower segmentation of customers, which allows manufacturers to more precisely tailor products and services. This also allows greater customization of manufactured products. Marketing campaigns can be improved based on social feeds, customer reviews and buying patterns

Big data can improve the development of the next generation of products and services. For instance, manufacturers are using data from sensors embedded in products to create innovative after-sales service offerings such as proactive maintenance – preventive measures that take place before a failure occurs or is even noticed.

Some manufacturing industries use big data to improve procurement, supply chain management and the logistics chain. An example is knowing when product shipments could be delayed based on ocean carrier data or other information sources for inventory in-transit. Big data optimizes sourcing of raw materials from multiple vendors and tracks inventory positions in real time, even across multiple geographies and company divisions. Logistic specialists can use data to select the best truck routes in real time to boost delivery speed while reducing fuel costs.

The University of Idaho has led the build-out of data management infrastructures to support data management research and education across the state. In 2010, it launched the Northwest Knowledge Network, a data-management infrastructure that provides data services to researchers, structures cooperation and collaboration among institutions that manage and use data and prioritizes research topics to keep Idaho on the cutting edge of data science and application.

Robotics

Falling costs and growing sophistication are making industrial robots increasingly common. Faster processors, sophisticated algorithms and improved sensors are making robots more versatile, faster and safer to work around humans. Rapid improvement in vision and touch technologies is putting a wide array of manual jobs within the abilities of robots. While earlier generations of robots required extensive programming to alter even small details of their routines, today's robots can respond more flexibly and can adjust their pace. Despite their enhancements, today's robots are considerably less expensive than traditional manufacturing robots. Even small manufacturers now can afford them.

With more Idaho companies using robotics and making smart devices, mechatronic and programmable logic controller technicians, or PLC technicians, are in high demand. "Mechatronics" comes from combining "mechanics" and "electronics" and requires knowledge of both fields as well as computer control. PLC technicians are responsible for designing, installing, operating and maintaining the electronic equipment and automated control systems in manufacturing plants and similar settings.

"Idaho has a noticeable history with robotics," according to Growing the Idaho Economy: Moving into the Future, a report prepared by Futurist.com for the Idaho Transportation Department. "The Idaho National Laboratories has an active research and development program in robotics and intelligence systems, focused on 'adaptive robotics.' The program develops machines that can adapt on the fly and can do things like detect and measure gamma radiation, clean up hazardous wastes remotely, swarm together to carry out tasks or fly autonomously. Each of the Idaho universities conducts research and provides education related to robotics; K-12 robotics competitions are well-known, and even the 4-H has a program in robotics in Idaho."

Encoder Products Co. in the Sandpoint area is a leading designer and manufacturer of motion-sensing devices. Founded in 1969, the business makes the most complete line of incremental and absolute shaft encoders in the industry, meeting the diverse needs of its customers around the world.

Pulse-Robotics in Eagle designs and makes social robots for educational, artistic, consumer and medical applications.

The New Artisan Economy

With growing interest in customization and locally made products, especially local food, sophisticated consumers are helping revive craft manufacturing. Many manufacturers who are thriving in the United States have done so by avoiding direct competition with low-cost commodity producers in developing nations. Instead, they have scrutinized the market and created customized products for less price-sensitive customers. Artisanal food and beverage makers are the fastest-growing segment of food processing. Makers of apparel, shoes, jewelry, leather products and furniture are rejecting the high-volume, low-margin commodity model of large firms and finding niches where engaged consumers pay a premium for a specialty product. Craftsmanship, making things by hand, and close relationships with customers characterize the new artisan economy.

Additive Manufacturing: 3D Printing

Three-dimensional printing may bring the biggest changes for manufacturing. Instead of making small parts from larger pieces of material by bending and cutting as manufacturers traditionally have done, 3D printers build things by depositing material, layer by layer. That is why the process is called additive manufacturing. 3D printers lay down successive layers of micro-thin material — usually plastic, polymer or metal. In some processes, a binding agent may be applied between each layer. An automated laser eventually fuses everything together. After doing this many times, it builds up from a series of cross sections and becomes a three-dimensional object.

That means 3D printing can create shapes of almost any size with extreme precision. With 3D printers, shoes, bikinis and even platinum wedding rings can be printed out to fit a customer's exact measurements. Depending on the size of the product, 3D printers range from as large as a car to as small as a microwave.

3D printing can mix materials that could not be compounded with traditional methods. It's possible to produce things that are rubbery at one end and stiff at the other. A camera body, for example, could be made in one piece but be soft where it is gripped and hard where the lens and the operating mechanism are installed.

A 3D printer can print an item as a complete part that requires no assembly. It can even make mechanical objects with moving parts in one uninterrupted process.

3D printers make creating prototypes far less expensive. Engineers use them to design many consumer goods and mechanical parts. Changes can be swiftly reprinted in a few hours while waiting for a new prototype to emerge from a machine shop can take weeks. Rapid prototyping using 3D printing allow engineers to test and update more versions of their prototypes – in some cases tripling the number of iterations of a new product that can be refined before being mass-produced. That allows them to produce more innovative, higher-quality products from custom-fitted bicycle helmets and prosthetics to better-sounding ear buds and loudspeakers.

Until recently, 3D printing was almost exclusively used to make prototypes. Now that the technology is more sophisticated and less expensive, more things are being printed as finished goods. 3D printing already produces commercially viable final parts in some niche applications such as highly customized parts for aircraft or medical devices like knee joints. Currently around 28 percent of the money spent on 3D printers is for making final products. That percentage should soar in the next few years.

3D printing promises unlimited customization. Since there are few economies of scale in additive manufacturing, the technology is ideally suited to low-volume production. It also allows the mass customization of finished parts. Millions of dental crowns and shells for hearing aids are already being made individually with 3D printers.

In the future, 3D printing will make it easier to replace parts. Even parts that are no longer available could be replicated, by scanning a broken item, repairing it virtually and then printing a new one. Urgently needed spares could be produced in remote places without having to ship anything.

3D printing is a potent technology for localization. They will simplify supply chains and make it easy to produce locally. They will manufacture what customers need at the physical location where it's needed.

Where 3D printers were once affordable only by large companies, they now are affordable for small businesses and hobbyists. Some people envision the day when they become common household appliances.

The DIY Maker Movement

The DIY Maker, or micro-manufacturing, movement potentially may change where products are made. Makers are do-it-yourself people who are designing and building their own products. They use open-source methods and the latest technology to bring manufacturing out of the traditional factory context and into the realm of the personal desktop computer. Many hobbyists are intrigued by 3D printing and are purchasing the new desktop printers. In his 2012 book "Makers: The New Industrial Revolution," Chris Anderson, the editor of Wired magazine, says, "What's happened over the last five years is that we've brought the Web's democratizing power to manufacturing. Today, you can manufacture with the push of a button."

As the cost of 3D printers falls over time, the Maker movement could gain steam. Anderson detects the re-emergence of the American spirit of tinkering and building, retooled and made user-friendly for the Internet Age. Today, individuals can upload their own designs to a cloud-based printing service and order 1,000 units. "You don't need to be a company, you don't need permission, you don't need to fly to China," Anderson says. "It's just point-and-click, and they take credit cards."

Makers tend to form communities – both online and in person. Through collaboration, they hone their ideas and find solutions to problems. Many maker communities create makerspaces. These technical shops where members can use industrial tools including 3D printers, laser cutters and traditional tools are spreading across the country. Darpa, a Department of Defense agency responsible for developing new technologies for the military, is sponsoring the creation of makerspaces in thousands of American schools

Crowdsourcing is common in the maker culture. The open-source manufacturing business model encourages inventors to publish their plans and specifications under an open source license, which allows others to copy, adapt and learn from the designs.

"Now we have an opportunity to take millions of people out there with ideas and turn them into entrepreneurs," Anderson said. "I can imagine 10 years from now that we will have an explosion of micro factories and startups in the manufacturing space, which bring back more jobs and a different kind of manufacturing to the U.S., doing something that we do very well, which is not low-cost labor but high-frequency innovation and Web-style collaboration."

Open Lab Idaho in Garden City is "a community hackerspace and makerspace that promotes creative, technological and educational collaboration by hackers, computer geeks, engineers, circuit benders, crafters, tinkers, programmers and artists," according to its website. It is currently expanding its space to include a machine shop where members can store projects, tools and machines. Among the machines that will be available are CNC mills, 3D printers, saws, grinders, soldering equipment and hand tools.

Make IT is a project to create makerspaces in five library sites across Idaho and encourage the delivery of library services to digital users "where they live." The Idaho Commission for Libraries is providing the necessary materials and training to implement creative, STEM-based programming for middle schoolers and teens. Librarians are learning about makerspaces and ways of engaging teens with science and technology. Each participating library is required to dedicate the staff and space necessary to create a makerspace accessible by teens and other patrons. The participants are Ada Community Library, Community Library Network serving Kootenai and Shoshone counties, Gooding Public Library, Meridian District Library and Snake River School Community Library in Blackfoot.

Northwest Nazarene University in Nampa is creating a maker lab that will allow 3D design and printing with a $200,000 equipment grant from Hewlett-Packard.

The Future

The Third Industrial Revolution probably will result in diverse, widely distributed, smaller-scale manufacturing shops that provide customized service to local consumers. Innovations will accelerate, sparked by more direct interaction between customers and manufacturers, and the public sharing of ideas by hobbyists.

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